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ANNUAL REPORT

Pasture and Range Investigations
Ephraim, Utah

INTERMOUNTAIN STATION
Central Reference File
No. 9.41

Forage and Range Section
Field Crops Research Branch

in Cooperation with

Intermountain Forest and Range Experiment Station
and
Utah Agricultural Experiment Station

By William J. McGinnies, Range Conservationist

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INTRODUCTION

During 1955, the field work at Ephraim has been directed mainly toward two main objectives. These are to conclude observations on old strain trials and to start new work on methods of seeding. This annual report will be primarily concerned with these two subjects.

In the past, a number of strain trials have been established in the vicinity of Ephraim. In each vegetal zone, all available seed sources were planted in one or more locations. Most of these studies are now old enough that reliable data on strain differences can be obtained. This year it was decided to go through these studies and bring the data up to date. Rather than try to do all this at once, only crested wheatgrass and related species were considered this year. The present plan is to take final data on several species each year until all species have been completed. The data will be summarized for all the years of the study. The first concern is to determine which strains are best, but it is also desired to make these data available to plant breeders so that they can see how the various strains react under central Utah conditions. These data will also be examined to determine the possibilities of using them for publication.

The methods of establishment phase of the work at Ephraim was expanded this year. Included in this report are data on a

seed treatment study and a deep furrow study. There will also be found an establishment report on a preliminary severe site study. One of the problems in studying methods of establishment has been to determine what factors are responsible for the success or failure of a range reseeding. Some time has been spent trying to determine what these factors are, their relative importance, and methods of studying them. Some pilot studies on soil temperature and soil moisture are planned for next year.

CRESTED WHEAT GRASS STRAIN TRIALS

In past years, a number of studies were established to determine which strains or seed sources of adapted grasses are most suitable for a particular situation. These studies are now old enough to provide reasonably dependable results. Because these studies have largely served their usefulness, and because maintaining these studies can be very time consuming, it has been decided to wind up these studies during the next few years. The best way to handle these studies appears to be to take one to several species each year, bring the data up to date, and compile and summarize the results. In line with this plan, during the spring of 1955 data were gathered for all of the studies where crested wheatgrass is planted, and these data, along with the data from past years, are summarized in this report.

The purpose of this report on strains is twofold. The first and most important purpose is to show which strains produce the highest yield on the particular sites involved. As far as these yields are concerned, these data may be somewhat misleading because the yields are taken from protected small plots and do not necessarily show the production that would be obtained under grazing. Yields were taken at about the period of peak growth and do not indicate regrowth characteristics. Further, these yields do not necessarily reflect the amounts of nutrients produced; there may well be substantial differences in the nutrient levels of the

various strains. Although all yields shown are green weights, there would probably be little difference in the relative rankings of the various strains because most of the strains tend to have about the same moisture content at any given time with the exception of the Fairway types which tend to be a little drier at the time the data are taken.

The other principal purpose of getting the summaries together is to try to provide some help to the plant breeders. Some of the strains in these studies were developed by the plant breeders and sent out for testing. It is hoped that these summaries will provide them with some information as to how their strains are comparing with other strains under the growing conditions at this location. Many of the strains and seed sources are of local origin. If any of the breeders are interested in getting seed or plants of these local sources, an effort will be made to supply them with this material.

The data in the tables to follow are based on ocular estimates of yield in pounds per acre. The technique used is to estimate the number of grams of herbage on a given area and then convert this to pounds per acre. Frequent checks are made by actually clipping and weighing samples of the herbage. Although this method of estimating yield is subject to numerous errors, it is felt that the method is adequately precise for the type of study involved here.

On the following pages are brief descriptions of the various study areas and tables showing the herbage yields for all years when data were collected. The yield shown is the average of all blocks for that particular strain and year. The final column is the average yield for each strain for all years in which data were taken. An analysis of variance was applied to this final column and the least significant difference calculated when the "F" value indicated that the differences were significant. Immediately following this section of study area descriptions and yield tables will be found a list of the various strains which shows the source of the seed.

MAJOR'S FLAT

Studies E-12 and E-12 Supplement No. 2 Crested Wheatgrass Strain Trials.

Study E-12 is located in the Major's Flat enclosure while Study E-12 Supplement No. 2 is located just outside the enclosure to the north. The Major's Flat enclosure is about five miles east of Ephraim, just east of and inside of the Manti-LaSal National Forest boundary fence, and on the north side of the Ephraim-Orangeville road.

Study E-12 is on a fairly level spot where the clay loam soil is very deep. This soil is of very high fertility. It was developed under a dense stand of Gambel oak and sagebrush; these two species plus juniper and grasses probably made up the native vegetation on this area. The area was used as a sheep bed ground prior to 1900 and most of the palatable native species were killed out.

Study E-12 Supplement No. 2 is located on a severe south-facing sidehill. Native vegetation on this site was a sparse stand of juniper and sagebrush. The soil is an eroded lithosol except where the scattered junipers formerly stood; here some good soil and organic matter has been built up. Mostly, the soil is coarse and covered with a thin pavement of small pieces of shale and limestone. This is a very severe site.

The elevation at Major's is about 7200 feet. Average annual

precipitation is probably 15 to 16 inches. The general area would be classed as being in the mountain brush zone.

Both sites were cleared by burning. After the burn, the standing stumps were cut out by hand. For Study E-12, this was followed by a light disking to smooth up the area.

Study E-12 was planted April 12, 1949. The plots measure 5x10 feet and contain three rows ten feet long and spaced twenty inches apart. The seeds were planted in furrows and covered with ¼ - ½ inch of soil. Four blocks were planted.

Study E-12 Supplement No. 2 was planted in the fall of 1950. The plots measure 5x10 feet and contain three rows ten feet long and spaced twenty inches apart. The seeds were planted in furrows and covered with about ½ inch of soil. Two blocks were planted.

Crested wheatgrass is well adapted to this zone, but a number of species will out-produce it on the better sites (such as Study E-12). However, on severe dry sites, such as Study E-12 Supplement No. 2, crested wheatgrass is the best species tried so far. The mountain brush zone is well suited to range reseeding IF the competing brush can be eliminated. The potential production in this zone is exceptionally high. Before such reseeding can be considered practical, satisfactory methods of eradicating the sprouting species of brush, such as Gambel oak, must be found.

		1949	1950	1951	1952	1953	1955	Mean
Agropyron cristatum	28B2	1500	4575	5112	7325	4225	3275	4333
	29A2	1600	5225	5538	7000	4550	3700	4602
	31A2	1900	4275	5362	7450	4675	3525	4531
	35	1800	6225	6775	7600	4375	3600	5062
	36	1375	5200	5438	8050	4125	3550	4623
	42	888	3775	5000	6900	4200	3300	4010
	43	1925	5700	6100	7450	4425	3650	4875
	49	1750	6100	5912	7200	4425	3950	4890
	50	1450	5800	6338	6975	4225	3775	4760
	65	1700	6100	5912	7200	4425	3950	4890
	70	1475	5550	5538	6825	3950	3625	4494
	71	1325	4325	4875	7800	4200	3300	4302
Agropyron desertorum	2A	1875	5325	5400	7450	4500	3450	4667
Agropyron sibericum	10A2	1225	5825	5900	6650	4025	3450	4512
					Grand Mean			4659
					L.S.D. 5%			425
					L.S.D. 1%			569

STUDY E-12, SUPPLEMENT NO. 2

Species and Lot		1952	1953	1955	Mean
Agropyron cristatum	28B2	495	900	1225	873
	29A	725	1275	1400	1100
	30	525	800	1100	808
	30A	515	925	1200	880
	31A2	420	700	1050	724
	35	425	400	300	375
	38A	560	775	1550	962
	39A	820	875	1000	898
	40A	460	675	850	662
	41A	475	725	1200	800
	43A	560	750	1100	803
	44	520	1000	1600	1040
	65A	700	1050	1650	1133
	67	725	1175	1500	1133
	68	435	725	1000	720
	70	650	1150	1200	1000
	72	435	700	1225	786
	73	535	500	950	662
	74	710	675	1275	886
	75	700	825	1650	1058
	77	575	675	750	666
	79	385	550	1150	695
	80	710	800	1375	962
Agropyron desertorum	2A	550	600	1000	716
	3	400	700	725	608
Agropyron michnoi	1A1	700	1100	1750	1184
Agropyron sibericum	10A2	515	490	475	494
	11A2	360	270	575	402

Grand Mean	822
L.S.D. 5%	316
L.S.D. 1%	N.S.

Strains of crested wheatgrass growing in Study E-12 at Major's Flat in Ephraim Canyon. 1949 planting. Picture taken August, 1954.

The planting on the hillside beyond the fence and below the junipers is Study E-12 Supplement No. 2. The hillside faces toward the south-west and is of somewhat greater slope than the picture would indicate. Compare production on hillside with mixture planting on better soil in foreground. Picture taken 7/6/55.

Strains of crested wheatgrass growing in Study E-12 Supplement No. 2 at Major's Flat in Ephraim Canyon. 1950 planting. Picture taken 7/6/55.

PIGEON HOLLOW

Study B-120 Crested Wheatgrass Strain Trials.

This study is located on the Hatfield farm in Pigeon Hollow about six miles north of Ephraim and just east of Highway 89. The elevation is about 5800 feet. Average annual precipitation is probably 12 inches. This study is located on an old aluvial fan. The surface soil would be classed as a fine sand, but the sub-soil is heavy and strongly calcareous. The general fertility level of this fan appears to be moderate.

The original native vegetation on this study area was probably of the Juniper-Sagebrush-Grass type. The sagebrush and perennial grasses have largely been killed out. At the time the study was established, the vegetation consisted of juniper and cheatgrass. Much of the adjacent area has been cleared of juniper and is being farmed; some is dry farm and some is irrigated. In general, dry land crops have been rather low-yielding because of low rainfall and limited fertility.

The junipers were cleared from the study area in 1945 by a bulldozer. The ground was disc-harrowed in the spring of 1946 just prior to planting.

Study B-120 was planted on April 1, 1946. The plots are ten by fourteen feet in size. The rows are fourteen feet long and approximately fourteen inches apart. The seed was planted in shallow furrows and covered with about ½" of soil. Two blocks were planted.

The results from this study are somewhat more variable than usual because of the native juniper vegetation that was on this site prior to clearing. Immediately under each juniper tree the accumulation of needles has resulted in a fertile soil very high in organic matter being built up. Between the trees, the soil contains little organic matter and is much less productive. The scattered nature of the trees results in frequent small areas of higher productivity than is normal for the remainder of the area. When a plot falls on one of these areas of high productivity, it will tend to show a much higher yield than a comparable plot on the low organic matter soils. The difference that results from this soil difference is far greater than most strain differences. It is probably because of this non-uniformity of the soil that the yields of this study do not show a significant difference on the F-test.

Species and Lot		1948	1950	1951	1952	1953	1955	Mean
Agropyron cristatum	13	525	1025	2050	1850	1950	800	1367
	28A	800	925	1850	1700	1950	825	1342
	29	500	1125	2150	2100	1850	825	1425
	30	850	1000	1925	1750	1950	775	1358
	31	700	1250	2125	2150	2000	925	1525
	31A	700	1250	2100	2250	2150	950	1566
	36	438	320	1000	1050	1050	850	784
	37	340	575	1325	1250	1250	475	869
	38	400	1000	1700	2000	1950	700	1292
	39	825	1175	2100	1875	1900	950	1470
	40	825	1225	1850	1950	1850	825	1421
	41	750	1275	2350	2350	2000	875	1600
	42	475	1150	1925	1750	2000	700	1334
	44	450	925	1650	2800	1950	775	1425
	45	725	1075	2200	2250	1600	850	1450
	49	600	1100	1850	2000	1750	575	1312
Agropyron desertorum	2	775	1025	2150	2150	1950	725	1462
Agropyron sibericum	9	380	225	1200	1075	950	475	717

Grand Mean	1318
L.S.D. 5%	N.S.
L.S.D. 1%	N.S.

General view of crested wheatgrass strains growing in Study B-120 at Pigeon Hollow. The open stand of juniper in the background is similar to the vegetation that was on the study area prior to clearing. 1946 planting. Picture taken 7/18/55.

SORENSON'S FIELD

Studies E-6 and E-6 Supplement Crested Wheatgrass Strain Trials.

These studies are located in an enclosure in a field owned by Walter Sorenson; the enclosure is about ½ mile south of Ephraim on the Ephraim-Orangeville highway. A number of other studies are also in this enclosure. The elevation at this site is 5600 feet. Annual precipitation is about 11 inches. The enclosure is located on a large alluvial fan of relatively recent origin. The soil is a silt loam of generally low productivity, even when irrigated. The soil is shallow with a carbonate layer occuring between 15 and 20 inches. Below about 6 inches, the soil contains many large river-worn boulders.

The vegetation at this site was originally the low-rainfall sagebrush-grass type. However, it is very close to town and has been severely overgrazed for a long time. Vegetal depletion had reached such a state that this general area has been referred to as "starvation pasture". At the time the enclosure was established, the area was supporting a thin stand of cheatgrass and rabbit brush.

This area was plowed in 1939 and cultivated just prior to planting.

Study E-6 was planted April 6, 1944. Plots are 3 feet wide, 10 feet long with three 10 foot rows 12 inches apart. Two blocks were planted.

Study E-6 Supplement is a continuation of Study E-6 containing newer strains. Study E-6 Supplement was planted on November 7, 1950.

Plots are 5 feet wide and 10 feet long with three 10 foot rows 20 inches apart. Two blocks were planted.

In both studies, the seed was planted in shallow furrows; the seed was covered with ¼ - ½ inch of soil.

This site represents about the lower limit of rainfall at which crested wheatgrass can be grown with good success using presently known cultural methods. This site has a relatively poor soil and provides a rather critical test of the various strains. Crested wheatgrass is probably the species best adapted for range reseeding on this type of site.

STUDY E-6

Species and Lot		1945	1946	1947	1948	1949	1953	1955	Mean
Agropyron cristatum	13	2360	1390	2200	975	1600	925	725	1453
	21	2350	1415	2650	1300	1500	850	775	1548
	22	2310	1330	2325	1200	1700	1000	625	1498
	23	2110	1050	1950	1075	1550	800	775	1330
	24	2370	1180	2075	1250	1600	925	850	1464
	26	2450	1480	2300	1425	1750	1050	700	1443
	28	1510	940	1740	975	1400	1075	875	1216
	29	2290	1170	2350	1350	1850	875	900	1540
	30	1390	865	1900	875	1350	800	800	1140
	31	1880	1110	1800	1075	1450	800	800	1273
	32	2460	1195	2550	1375	1900	1100	1100	1668
Agropyron sibericum	4	1680	1170	2200	950	1350	650	875	1268

Grand Mean	1404
L.S.D. 5%	151
L.S.D. 1%	N.S.

E-6 SUPPLEMENT

Species and Lot		1952	1953	1955	Mean
Agropyron cristatum	28B2	1300	1650	750	1233
	29A	1500	1950	825	1425
	30	1550	1800	775	1375
	30A	1350	1550	775	1225
	31A2	1450	1950	650	1350
	35	1250	1150	825	1075
	38A	1450	1850	750	1350
	39A	1025	1350	800	1058
	40A	1500	1350	800	1217
	41A	1550	1700	800	1350
	43A	1300	1600	675	1192
	44	1650	1600	700	1317
	65A	1300	1850	725	1292
	67	1250	1600	650	1167
	68	1750	1850	900	1500
	70	1400	1850	775	1342
	72	1900	1800	925	1542
	73	1500	1650	800	1316
	74	1100	1600	725	1142
	75	1200	1450	675	1108
	77	1500	1650	775	1308
	79	1250	1400	600	1084
	80	1700	2000	725	1475
Agropyron desertorum	2A	1075	1550	800	1142
	3	1500	1800	950	1416
	4	1000	1250	625	958
Agropyron michnoi	1A1	750	950	400	700
Agropyron sibericum	10A2	925	900	450	758
	11A2	875	1050	550	825
	12	1300	1650	600	1183
			Grand Mean		1214
			L.S.D. 5%		261
			L.S.D. 1%		351

Strains of crested wheatgrass growing in Study S-6 south of Ephraim. 1944 planting. Picture taken 7/5/55.

Strains of crested wheatgrass growing in Study E-6 Supplement. 1950 planting. Picture taken 7/5/55.

GUNNISON SHADSCALE

Studies E-10 and E-10 Supplement No. 2

Crested Wheatgrass Strain Trials

These studies are in the Gunnison shadscale enclosure; this enclosure is located about 2 miles north-east of Gunnison, Utah on a low divide between Gunnison and Christianburg, and is about ¼ mile north of Highway 89.

The elevation of this study is approximately 5500 feet. Annual rainfall is about 10 inches. The soil is quite sandy and very immature. Examination of soil pits at this location would indicate that the surface 18 inches of this soil was deposited upon a much older and more highly developed soil. The surface 18 inches is weakly differentiated into horizons. Little or no aggregation is apparent, but crusting is not a problem because of the sandy nature of the soil.

The present vegetal cover on this area is primarily shadscale with a small amount of winterfat and Opuntia sp. scattered through. No doubt, at one time, winterfat and grass made up a major part of the plant cover. This general area appears to have once been a transition zone between the sagebrush-grass type and the salt desert shrub type; very little sagebrush occurs in this general area now.

The study areas were prepared by hand grubbing the shadscale and a surface cultivation just prior to planting.

Study E-10 was planted on December 11, 1947. The strains were

planted in plots measuring 5x10 feet and containing 4 rows 10 feet long and 15 inches apart. Four blocks were planted.

Study E-10, Supplement No. 2 was planted on November 16, 1950. Plots are 5x10 feet in size and contain 3 rows 10 feet long spaced 20 inches apart. Two blocks were planted.

All seeds were planted in shallow furrows and covered with about ½ inch of soil.

This site is probably too poor for general reseeding to crested wheatgrass. Although good success has been obtained from experimental plantings, it is questionable that large scale reseeding would be uniformly successful using reseeding methods in common use today. However, crested wheatgrass and Russian wildrye are the species best adapted to this site and are the species that will be used for further study in this area.

STUDY E-10

Species and Lot		1951	1952	1953	1955	Mean
Agropyron cristatum	28B2	315	1175	825	800	779
	29A	285	875	650	650	615
	30	382	1150	938	538	752
	31A2	400	1000	650	650	675
	35	225	825	412	688	538
	36	292	1050	900	838	770
	37	150	538	358	350	349
	39	202	700	375	588	466
	40	220	775	462	625	521
	41	282	1075	740	462	640
	42	195	550	410	412	392
	43	239	725	512	625	526
	44	189	612	400	288	424
	45	166	625	338	500	407
	58	325	1000	675	650	662
	65	370	1125	588	712	699
Agropyron desertorum	2A	418	1200	812	912	836
Agropyron sibericum	10A	225	688	550	638	525
	11A2	85	248	172	338	210
			Grand Mean			568
			L.S.D. 5%			180
			L.S.D. 1%			240

STUDY E-10, SUPPLEMENT NO. 2

Species and Lot		1952	1953	1955	Mean
Agropyron cristatum	28B2	425	775	850	648
	29A	375	675	950	667
	30	450	725	600	591
	30A	525	500	400	475
	31A2	225	450	550	408
	35	275	425	350	350
	38A	350	500	450	434
	39A	425	725	750	634
	40A	525	925	1125	857
	41A	375	750	1100	742
	42A	250	500	575	442
	43A	200	660	500	454
	44	325	675	675	558
	52	175	475	400	350
	65A	400	575	750	575
	67	650	950	800	800
	68	525	900	875	767
	70	325	700	500	508
	71	275	475	825	525
	72	350	750	600	567
	74	300	450	500	416
	77	400	750	775	642
	79	150	325	600	358
	80	575	825	675	692
Agropyron desertorum	2A	375	600	700	558
	3	475	600	425	500
Agropyron sibericum	10A2	275	350	500	375
	11A2	225	325	725	425
			Grand Mean		548
			L.S.D. 5%		N.S.
			L.S.D. 1%		N.S.

Native vegetation growing in Gunnison Enclosure, two miles north-east of Gunnison, Utah. The vegetation growing here is mostly shadescale, prickly-pear, and Russian thistle. This vegetation shows little improvement in spite of several years protection. Picture taken 5/4/55.

Strains of crested wheatgrass growing in Study E-10 Supplement No. 2 in the Gunnison Enclosure two miles north-east of Gunnison, Utah. 1950 planting. Picture taken 5/4/55.

RASMUSON FARM

Study E-11

Crested Wheatgrass Strain Trials

This study is located in a field belonging to Robert Rasmuson; the field is about 3/4 mile south-east of Ephraim and is about 300 yards south of the Ephraim-Orangeville road. Elevation is slightly over 5600 feet. Average annual precipitation is probably about 11 inches. This study is located on the same alluvial fan as are the Sorenson's Field studies; however, the soil on Rasmuson's farm is silty, deep, and quite fertile. This study is at the lower end of a field that was formerly irrigated; the irrigation water carried quite a bit of soil from the upper end of the field and deposited it on the lower end where Study E-11 is located. The soil on this study area is, by local standards, a good quality agricultural soil when it is irrigated.

The original vegetation on this area was sagebrush and grass. It is just below the lower limits of the pinyon-juniper type. Heavy grazing has largely eliminated the grasses from this area, and the juniper is slowly moving downhill and invading the general area. The field on which this study is located was cleared and put into cultivation around 1900. The area was under cultivation until about 3 years prior to the establishment of this study, and it had reverted to annual weeds and bindweed.

Study E-11 was planted on April 5, 1949. The plots measure

5x10 feet and contain 3 rows 10 feet long spaced 20 inches apart. Four blocks were planted. The seeds were planted in furrows and covered with ½ - 1 inch of soil.

Study E-11, and Studies E-6 and E-6 Supplement (Sorenson's Field) are located about ½ mile apart and receive essentially the same precipitation. The big difference between the two areas is in the quality of the soil. Whereas the quality of the soil at Sorenson's field is quite poor, the soil at Rasmuson's farm is good. The differences between the two areas are primarily the result of differences in soil.

Areas such as Rasmuson's farm are ideal for range reseeding. Some trouble from soil crusting has been experienced, but this has not been a serious problem. Crested wheatgrass is one of the best grasses for range reseeding on this site. Intermediate wheatgrass and pubescent wheatgrass will generally yield more than crested wheatgrass and may be superior to it in the long run. Only time will tell.

Species and Lot		1950	1951	1952	1953	1954	1955	Mean
Agropyron cristatum	28B	1000	1400	2438	2950	2025	3450	2210
	29A2	762	975	1462	2050	1400	2325	1498
	31A2	950	1200	2238	3050	2175	3550	2194
	35	239	575	738	975	675	1600	800
	36	712	1050	1550	1875	1700	2850	1623
	37	45	53	150	225	375	1025	312
	42	42	100	275	400	425	1450	448
	43	688	1137	1738	2100	1775	2800	1706
	49	1050	1212	1925	2750	2125	3200	2044
	50	592	1400	2225	2850	2000	3225	2049
	65	1725	1825	3025	3300	2350	3825	2675
	70	975	1275	3025	2775	1725	3475	2042
	71	1125	1388	2700	3000	2175	3900	2382
Agropyron desertorum	2A	650	975	1437	2150	1600	2750	1594
Agropyron sibericum	10A2	270	389	475	888	612	1275	652
						Grand Mean		1615
						L.S.D. 5%		374
						L.S.D. 1%		501

Strains of crested wheatgrass growing in Study E-11 at Rasmuson's farm about 3/4 mile south-east of Ephraim, Utah. 1949 planting. Picture taken 7/6/55.

The following list shows all of the seed sources used in the Crested Wheatgrass Strain Trials. The lot number listed is the number assigned to the seed at the Great Basin Research Center. When a lot number is not followed by a letter, it generally indicates an original source of seed. When the number is followed by a letter (or letter and number), it indicates that the seed has been collected from plants grown locally. Thus, lot 28 is seed obtained from the S.C.S. as P-8116, while lot 28B is seed collected from plants grown from lot 28 seed at Major's Flat.

It must be remembered that the locally collected seed is not necessarily of the same genetic makeup as the original seed. In many cases, there can be little doubt that pollen from other strains on adjacent plots has contaminated the original source, and the collected seed is not a true representation of the original. However, it should be noted, that in most cases, the locally collected seed seems to produce plants that are very similar to the original plants in most characteristics.

It will be noted that several sources come from seed collected off of old plantings. On these old plantings, the original sources of the seed are not known.

It will be noted that throughout this study, the current distinction between Agropyron cristatum and A. desertorum has not been made. The names used are those that appeared on the packets containing the original seed. No attempt has been made to classify the plants grown into the two species because of the great variations

found within a single seed source. Agropyron sibericum and A. michnoi are so similar to the A. crustatum - A. desertorum complex that they are included in the tables. Although there appear to be substantial differences in the grazing value of the Standard and Fairway types of plants, no attempt will be made to consider these differences at this time.

SOURCES OF SEED USED IN STRAIN TRIALS

Strain	Source
Agcr 13	Fairway strain from Porter Walton Seed Co. Commercial Seed. 1940.
Agcr 21	Obtained from B.P.I. C1-W59. Apparently from Pullman, Washington. 1941.
Agcr 22	Obtained from B.P.I. C2-W3358. 1941.
Agcr 23	Obtained from B.P.I. C3-1776. Apparently from Nebraska. 1941.
Agcr 24	Obtained from B.P.I. F.C. 22755. 1941.
Agcr 26	Collected from a 1929 planting at Major's Flat. Original source unknown. 1941.
Agcr 28	Obtained from S.C.S. P-8116. (1940 seed) 1943.
Agcr 28A	Progeny of Lot 28 grown on John K. Olsen farm near Ephraim, Utah. 1945.
Agcr 28B	Progeny of Lot 28 grown at Major's Flat. 1946.
Agcr 28B2	Progeny of Lot 28 grown at Major's Flat. 1947.
Agcr 29	Obtained from S.C.S. A-12124. 1943.
Agcr 29A	Progeny of Lot 29 raised at Major's Flat. 1946.
Agcr 29A2	Progeny of Lot 29 raised at Major's Flat. 1947.
Agcr 30	Obtained from S.C.S. A-1770. 1943.
Agcr 30A	Progeny of Lot 30 grown at Major's Flat. 1950.
Agcr 31	From Univ. of Saskatchewan. Variety-Fairway. Sask. No 1350. Certificate No. 506. S.C. No. 62-2774. 1943.

Ager 31A	Progeny of Lot 31 grown on John K. Olsen farm, Ephraim, Utah. 1945.
Ager 31A2	Progeny of Lot 31, John K. Olsen farm, Ephraim, Utah. 1947.
Ager 35	Collected at Sorenson's Field near Ephraim, Utah. Source of original seed unknown. 1944.
Ager 36	Obtained through Wesley Keller. Bullock selection. No. 22704. 1945.
Ager 37	Obtained from Wesley Keller. Marked "A.cr 1". 1945.
Ager 38	Obtained from Wesley Keller. Marked "A.cr 2". 1945.
Ager 38-A	Progeny of Lot 38 grown at Major's Flat. 1949.
Ager 39	Obtained from Wesley Keller. Marked "A. cr 5". 1945.
Ager 39-A	Progeny of Lot 39 grown at Major's Flat. 1949.
Ager 40	Obtained from Wesley Keller. Marked "A. cr 6". 1945.
Ager 40-A	Progeny of Lot 40 grown at Major's Flat. 1949.
Ager 41	Obtained from Wesley Keller. Marked "A. cr 7". 1945.
Ager 41-A	Progeny of Lot 41 raised at Major's Flat. 1949.
Ager 42	Obtained from Wesley Keller. Marked "A. cr 8". 1945.
Ager 42A	Progeny of Lot 42 grown at Major's Flat. 1949.
Ager 43	Obtained from Wesley Keller. Bullock selection. No number. 1945.

Ager 43-A	Progeny of Lot 43 grown at Major's Flat. 1949.
Ager 44	Obtained from Clarence Paxman, Nephi, Utah. 1944.
Ager 45	Collected from old study at Sorenson's Field. Original source unknown. 1945.
Ager 49	Seed collected at Major's Flat. Original source reported to be Lot 30. 1945.
Ager 50	Collected at Major's Flat. Original source reported to be Lot 29. 1945.
Ager 52	Collected from old planting near Great Basin Research Center Headquarters (elev 8800 ft.). Original source unknown. 1944.
Ager 58	Obtained from Kelley Western Seed Co. Commercial seed. 1946.
Ager 65	Collected from an old planting at Major's Flat. Old stand is a large seeded, late maturing type. Original source unknown. 1947.
Ager 65A	Progeny of Lot 65 grown at Major's Flat. 1950.
Ager 67	Obtained from S.C.S. P-61. (1945 seed). 1948.
Ager 68	Obtained from S.C.S. P-7406. (1945 seed). 1948.
Ager 70	Obtained from Wesley Keller. Sent for regional strain tests, entry 2. Strain 42-1. 1948.
Ager 71	Obtained from S.C.S. A-1770. Sent for regional strain tests, entry 1. 1948.
Ager 72	Obtained from Kelley Western Seed Co. Commercial seed. 1948.

Ager 73	Fairway. Obtained from Comstock, Pullman, Washington. PEI-119600. 1949.
Ager 74	Collected on Kendall Dry Farm west of Levan, Utah. Probably from commercial seed. 1949.
Ager 75	Obtained from L.C. Newell, Nebr. Agri. Expt. Sta. Neb. 10. 1950.
Ager 77	Collected on Victor Murray's place, Cisco, Utah. Probably from commercial seed. Growing on very dry site. 1950.
Ager 79	From Dominion Forage Crops Laboratory, Saskatoon, Sask. S 1350. PI-188938. 1950.
Ager 80	Fairway Strain. From Kelley Western Seed Co. Commercial seed. 1950.
Agde 1	Reproduced at Pullman, Wash. Obtained from S.C.S. P-11-37 (?). 1937.
Agde 2	Obtained from Wesley Keller. Collected at Forest Service increase planting at Logan, Utah. Originally from Lot 1. 1945.
Agde 2A	Progeny of Lot 2 grown at Major's Flat. 1946.
Agde 3	From Northern Great Plain Field Sta. No. 571 Sent for regional strain trials, entry No. 2-2. 1950.
Agde 4	Obtained from S.C.S. P-10. 1950.
Agmi 1	Obtained from Northern Great Plains Field Sta. No Number. 1944.
Agmi 1A1	Progeny of Lot 1 grown at Major's Flat. 1948.
Agsi 9	PI 108434. 1945.
Agsi 10	Obtained from B.P.I. P.I. 108429. 1945.

Agsi 10A	Progeny of Lot 10. grown at Major's Flat. 1946.
Agsi 10A2	Progeny of Lot 10 grown at Major's Flat. 1947.
Agsi 11	Obtained from Wesley Keller. Apparently bulk seed from Mandan. 1945.
Agsi 11A2	Progeny of Lot 11 grown at Major's Flat. 1947.
Agsi 12	Obtained from Comstock at Pullman, Wash. 44-86. 1949.

KenTh OnionSkin
OTTO H. COMETT U.S.A.

HYBRID POA STUDY

Past experience has shown that Poa pratensis is fairly well adapted to the aspen-fir and sub-alpine zones. It does exceptionally well under aspen canopy and on moister sites. However, the biggest drawbacks to the more widespread use of Kentucky bluegrass for range reseeding are its low forage yields and its great variations in production from year to year. It does have the advantage of providing excellent watershed protection on those sites where it is able to maintain a full stand. With the development of a series of Poa hybrids by the Carnegie Institution, it is hoped that it will now be possible to find a Poa that will give the ground cover of Kentucky bluegrass and at the same time yield a sizeable amount of forage. With this in mind, a test of 42 of these hybrids (and 3 strains of Kentucky bluegrass) was initiated in the Summit Enclosure in the sub-alpine zone.

The area used for this study was cultivated with a Merry Tiller in the summer of 1954. The seeds were planted June 22, 1955 following a light cultivation with a hand garden cultivator. It was not expected that so many strains would be sent; had this larger number of strains been anticipated, a larger area would have been prepared. Because of the limited area available, all strains were planted in single rows 12 feet long in two blocks. Although larger plots would be more desirable, it was felt that this arrangement would permit enough observations to eliminate many of the strains that were

North Onion Skin
Cotton Content 25%

obviously unsuited to sub-alpine conditions. With these eliminated, larger and more adequate tests can be made of the remaining species.

The snow had just melted on this area and soil moisture at the time of planting was very good, but almost no rain fell until early August. No germination was observed until after the rains came in August. In the meantime, a very heavy concentration of grasshoppers appeared on the study area. As soon as the seedlings would emerge, the grasshoppers would eat them off flush with the ground. The dense population of grasshoppers remained until well into September when, in some of the furrows, grasshopper feces were over ½ inch deep. The only seedlings that survived were those that received some sort of protection from old plant litter or the basal leaves of weeds. Thus, this year's planting appears to be largely lost.

A large scale airplane control program is contemplated for grasshoppers next year by the A.R.S. If this program goes through, it should be possible to control the grasshoppers on this study area with the aid of some additional hand spraying. It is planned that this study will be replanted next spring with the same strains being planted in the same rows as were used this year.

Following is a list of the strains planted and the average ratings for the seedling stands as determined on September 12, 1955. A plot diagram of this study has also been included.

HYBRID POA STUDY

			*Average plot rating
F.C.	32695	Poa hybrid	0.0
F.C.	32696	" "	0.0
	32697	" "	1.5
	32698	" "	1.0
	32699	" "	0.5
	32700	" "	1.0
	32702	" "	0.5
	32703	" "	1.0
	32704	" "	0.0
	32705	" "	0.0
	32708	" "	0.5
	32713	" "	0.0
	32716	" "	1.0
	32717	" "	0.0
	32718	" "	0.0
	32719	" "	0.5
	32720	" "	1.0
	32722	" "	0.0
	32723	" "	0.0
	32725	" "	0.5
	32727	" "	0.0
	32728	" "	0.0
	32729	" "	0.0
	32730	" "	0.5
	32731	" "	0.0
	32733	" "	0.0
	32736	" "	0.0
	32738	" "	0.0
	32740	" "	0.5
	32743	" "	0.0
	32745	" "	1.0
	32746	" "	0.5
	32747	" "	1.0
	32748	" "	0.0
	32750	" "	1.5
	32753	" "	0.5
F.C.	32755	Poa hybrid	0.0
	32756	" "	0.0
	32757	" "	0.0
	32758	" "	0.5
	32760	" "	0.5
	32764	" "	0.0
	32564	Common bluegrass	0.0
	32220	Merion bluegrass	1.5
P.I.	119684	Troy bluegrass	0.5

*Average rating for two plots.
10= full stand, 0=no stand.

POA HYBRIDS
SUMMIT ENCLOSURE
JUNE 22, 1955

	100	200	300	400	500	600
1	FC 32747	FC 32740	FC 32720	FC 32705	FC 32719	FC 32720
2	FC32729	FC 32719	FC 32758	FC 32716	FC 32750	FC 32758
3	FC 32705	FC 32698	FC 32730	FC 32746	FC 32738	FC 32718
4	FC 32716	FC 32723	FC 32718	FC 32745	FC 32740	FC32736
5	FC 32746	FC 32743	FC 32722	FC 32729	FC 32220	FC 32564
6	FC32745	FC 32728	FC 32736	FC 32757	FC 32747	FC 32731
7	FC32697	FC 32760	FC32731	FC 32697	FC 32760	FC32722
8	FC32704	FC32753	FC 32564	FC32695	FC 32723	FC32730
9	FC32727	FC32220	FC32748	FC32700	FC32698	FC32748
10	FC32696	FC 32750	FC 32708	FC32753	FC 32755	FC 32764
11	FC 32756	FC 32700	FC 32764	FC 32699	FC 32756	FC32708
12	FC 32757	FC 32699	FC 32713	FC32728	FC 32696	PI 119684
13	FC32738	FC32725	PI 119 684	FC 32725	FC 32727	FC 32733
14	FC 32695	FC 32703	FC32733	FC 32702	FC 32743	FC 32713
15	FC 32755	FC 32702	FC 32717	FC 32703	FC 32704	FC 32717

SINGLE ROWS 12' LONG

N ←

DEEP FURROW STUDY

One of the big problems in range reseeding is establishing a stand on the drier sites. The use of a deep furrow drill has frequently been recommended for these low rainfall areas. Past experience at Ephraim indicates that the deep furrow drill gives more dependable results than the regular disc drill. It has usually been assumed that the soil in the bottom of a furrow stays moist longer than the surface soil on an ordinary smooth seedbed. To date, this writer has not been able to find any publications that substantiate this conclusion.

In order to get some conclusive data on this matter, a deep furrow study was established in the early spring of 1955. The principal purpose of this study was to determine the soil moisture trends in that part of the soil where seed is normally planted under various degrees of furrowing and on a control area. It was also originally planned that some data on soil temperature would be obtained, but a too late discovery that the thermometers to be used were not satisfactory prevented such work.

Methods of Study

Seven different sizes and types of furrows plus a control were used in this study. These can be described briefly as follows:

control --- smooth soil surface

-1 ------ furrow 1 inch deep, 3 inches wide

-2 ------ furrow 2 inches deep, 5 inches wide

-3 ------ furrow 3 inches deep, 7 inches wide

-4 ------ furrow 4 inches deep, 9 inches wide

+3 ------ two mounds of soil, each 3 inches high and 7 inches wide, with a one inch space between the mounds, constructed on top of the soil surface

½+2,-2 -- furrow 2 inches deep and 5 inches wide, with a mound 2 inches high and 5 inches wide immediately adjacent to the furrow.

+2,-2 --- furrow 2 inches deep and 5 inches wide, with a mound 2 inches high and 5 inches wide immediately adjacent to the furrow, spaced such that there is no flat ground between the furrows.

A look at the pictures on the following pages will make these descriptions more meaningful. The furrows were constructed in plots 5 feet wide and 12 feet long, the long dimension being along the contour. Three furrows were constructed in each plot and spaced 20 inches apart on centers except for the "+3" where 2 pairs of mounds were constructed 30 inches apart, and in the "+2,-2" where the furrows were spaced 10 inches on centers. All furrows had a one inch wide flat area running along the bottom, and all mounds had a one inch wide flat strip running along the bottom, and all mounds had a one inch wide flat strip running along the top. Three replications of each treatment were used.

The study was located in the Sorenson's Field reseeding enclosure.

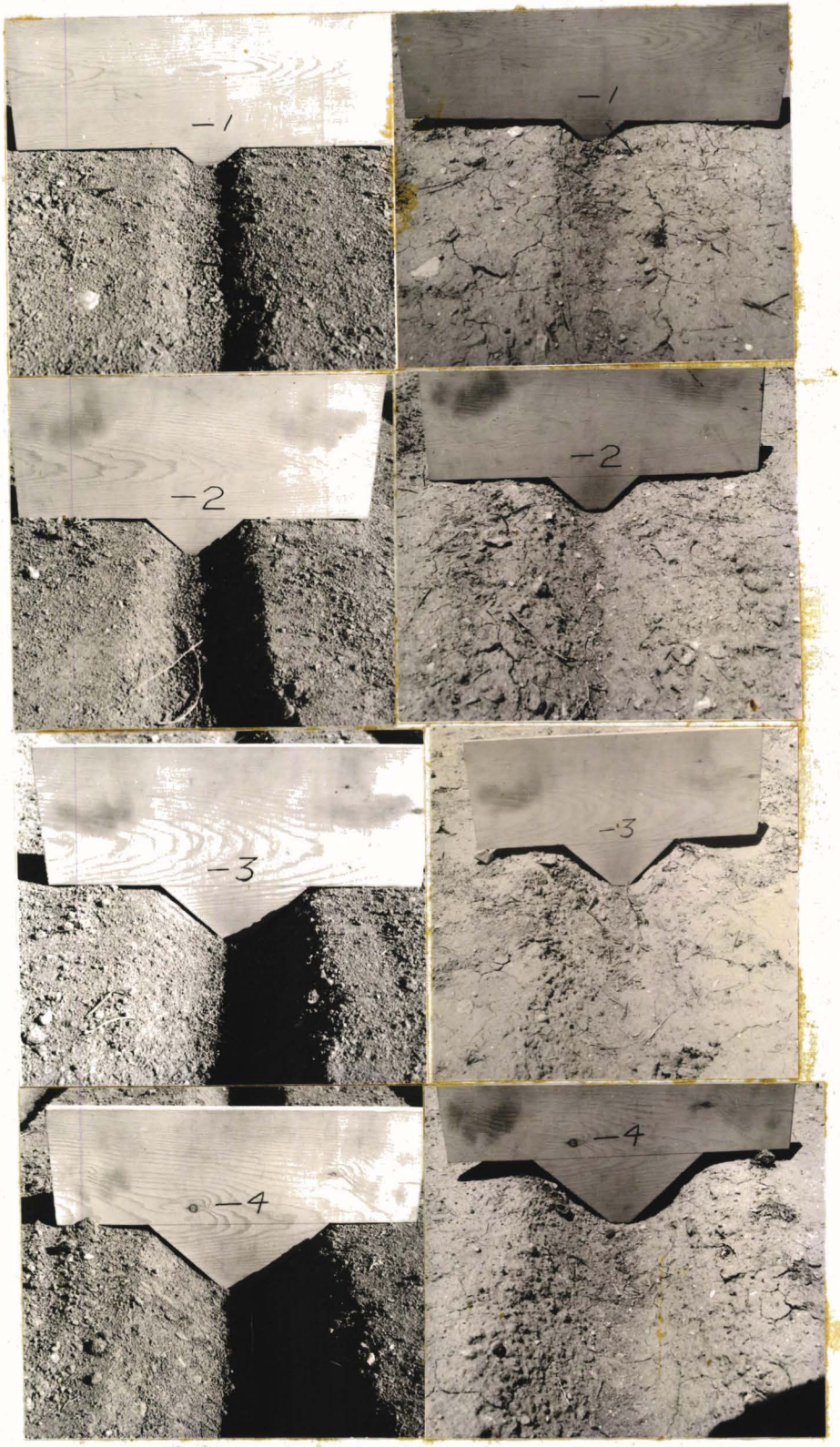
This enclosure is about ½ mile south-east of Ephraim. Elevation is 5600 feet. Average annual precipitation is about 11 inches. The soil is a shallow silt loam. Mechanical analysis of this soil shows 32.5% sand, 37% coarse silt, 16% fine silt, and 14.5% clay.

The study area was cultivated twice in 1954 with a Merry Tiller. Immediately prior to constructing the furrows, the area was cultivated about 1 inch deep with a hand cultivator and smoothed up with a hand rake. Templates of the exact dimensions of the finished furrows were made out of one inch lumber. It was hoped that these could be pulled along after the furrow had been roughly formed, and that the templates would leave a furrow of suitable size and shape. However, it was soon found that this method would not produce satisfactory furrows. In the method finally used, the templates were used to tamp the furrows into shape. This resulted in a furrow that closely matched the template, and one that gave all indications of being relatively stable and resistant to sloughing. Extreme care was exercised throughout the construction of the furrows to insure that all dimensions were held to minimum tolerances. All furrows were constructed on April 1, 1955.

Seeds of range grasses are usually planted between ½ inch and 1 inch deep; the common practice is to set the drill to sow ½ inch deep, but this usually results in seeds being well dispersed from the surface to an inch deep. Thus, the primary interest in soil moisture, in so far as germination is concerned, is with the surface inch of soil. Therefore, this experiment has been limited to the study of

On the following two pages are close-up pictures of the furrows with the wood templates in place. The pictures in the left column were taken on April 5, 1955 or four days after the furrows were constructed. These pictures show the furrows as they appeared when they were constructed. The pictures on the right were taken on June 24, 1955. These show the degree of change in furrow shape resulting from sloughing and settling of the soil.

Keith Onion Skin
COTTON CONTENT U.S.A.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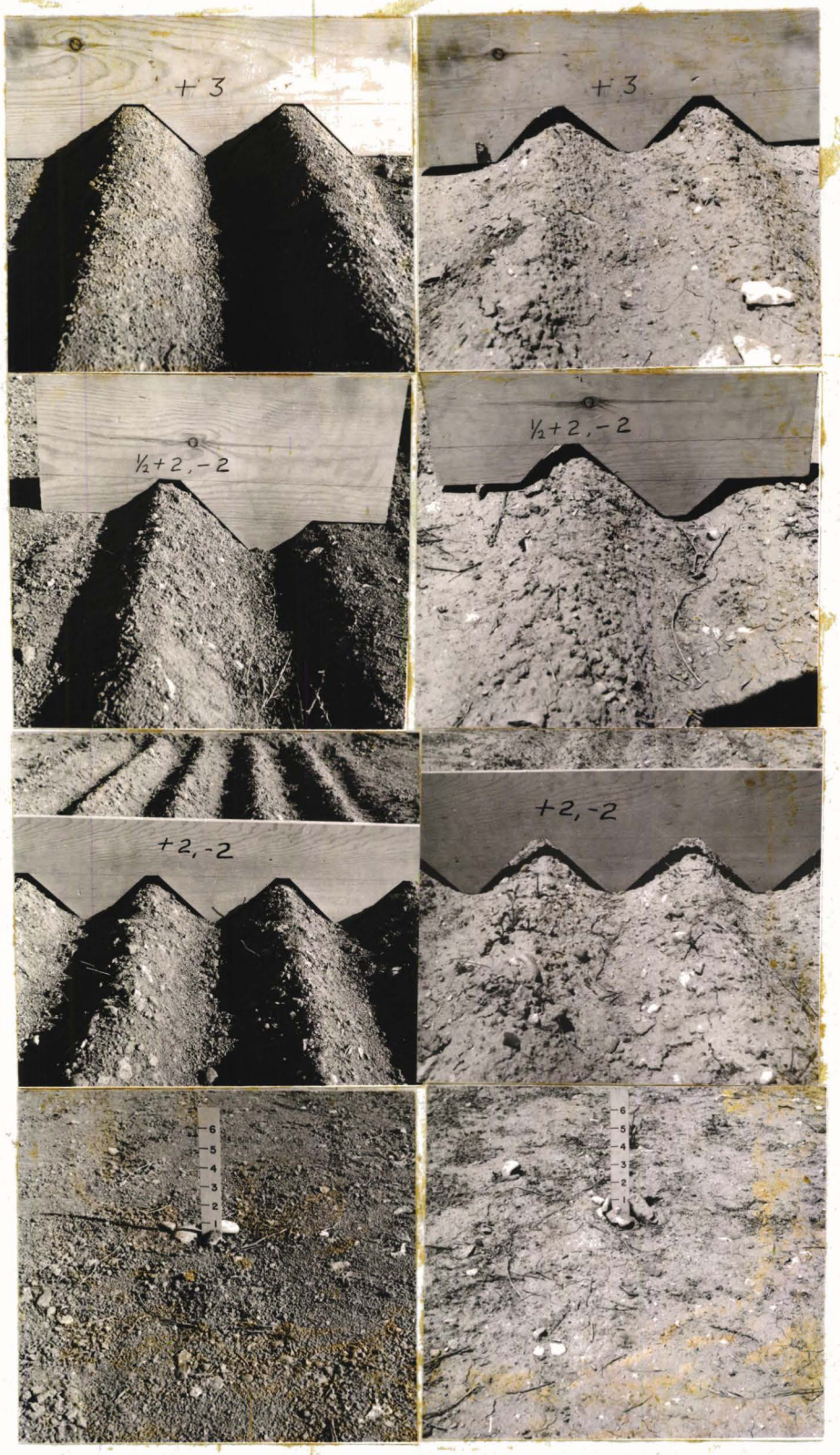

+3
+3
½+2,-2
½+2,-2
+2,-2
+2,-2

soil moisture in the surface inch of soil.

No suitable electrometric method of determining soil moisture could be found, so soil moisture was determined by oven-drying soil samples. The samples were collected with an open-sided soil tube of about 3/4 inch inside diameter; the top inch of the soil core was put in a soil can. Five such samples were collected on each plot and all put in the same can. This gave a total soil weight of about 50 grams per can.

The soil cans containing the moist soil were kept tightly covered and were weighed within one hour. Both wet and dry soil weights were recorded to the nearest .01 gram on a triple-beam balance. After weighing, the samples were dried in an electric oven at 105 degrees Centigrade for 22 hours, and reweighed. Percentage soil moisture was computed by the formula,

$$\frac{\text{weight } H_2O \text{ lost in drying}}{\text{weight of dry soil}} \times 100 = \text{percent soil moisture}$$

Soil moisture samples were taken at irregular intervals between April 6 and June 11. An attempt was made to obtain 3 sets of soil moisture samples each week. However, frequent storms sometimes upset this schedule. During the period of May 22 - June 6, it rained almost every day, and the surface soil stayed moist during the entire period. All soil samples were taken between 8 and 9 a.m.

Precipitation data were obtained from the Great Basin Research Center. They maintain a recording rain gage in the Sorenson's Field

enclosure; this gage is located about 25 yards from the furrow area. Although this gage is accepted as satisfactory by the U.S. Weather Bureau, it did not appear to be too accurate. On several occasions, when precipitation was accompanied by wind, sufficient rain or snow would fall to moisten the surface soil, yet no precipitation would be recorded on the rain gage chart.

An attempt was made to keep all plots as weed-free as possible. The plots were sprayed at regular intervals, and few weeds grew past the seedling stage. The one exception was glorybind which would not stay dead. The weeds were controlled to a point where they did not appear to have any effect on the soil moisture. All losses of soil moisture can thus be attributed to evaporation from the soil surface.

Results:

In general, the deeper the furrow, the higher will be moisture content of the surface inch of soil at any given time. It will be seen from the averages in the following table that at the 1% level of significance, all treatments except "-1" are significantly different from the control. Of the treatments plotted on the following graph, it will be seen that the "-4" was consistently the highest in moisture content, and the "-2" and "-3" were someplace in between "-4" and the control. The manner in which "-1" and the control parallel and re-cross each other is further evidence of the lack of a significant difference between the two.

The principal reason for the higher moisture content of the drying soil in the deeper furrows is evident on this graph during the periods of April 12-18 and May 3-12. It will be noted that on April 12 and May 3 that soil moisture was about the same for all treatments; this uniformity is the result of rains occurring shortly before these two dates. In both cases, the soil starts to dry out almost at once because of surface evaporation. However, almost immediately, differences in the rate of drying become obvious. The differences in rate of drying are most pronounced during the first 3 days following a rain. After 3 days, the rates of drying are relatively similar, but the deeper furrows have a much higher total percentage moisture resulting from the slower rate of drying during the first 3 days. It is the first 3 or 4 days following a rain that make the big difference.

With regard to the specific treatments, it is interesting to note that a 3 inch furrow "(-3)" was noticeably superior to paired mounds of soil 3 inches high "(+3)". From this, it would appear the beneficial effects of the furrows is due more to cutting below the soil surface than to the protecting effects of the sloping side walls of the furrow.

Although the "+2,-2" treatment was originally designed with a 4 inch depth from the ridge top to the furrow bottom, the soil on the ridges settled and sloughed off enough so that by the end of the first week, the total depth was little more than 3 inches. When it

Date	Average soil moisture								Precipitation
	Control	-1	-2	-3	-4	+3	½+2-2	+2,-2	
April 6	12.22	12.68	15.43	15.39	16.17	13.29	14.49	15.64	
10									.18
11									.02
12	15.02	15.11	15.49	14.95	15.43	15.12	14.83	15.28	
15	8.47	8.34	10.64	10.52	12.50	9.33	10.71	10.67	
18	7.24	7.17	9.19	10.98	12.16	8.17	9.56	10.44	T
20	7.64	7.76	9.11	11.04	11.95	8.66	10.15	10.25	
22	6.41	6.07	8.30	9.60	10.94	7.89	8.94	9.45	
25	5.23	5.68	7.92	8.99	9.97	7.74	8.10	9.07	
26									.07
28	7.52	8.50	10.16	10.63	11.79	9.60	10.48	10.46	
May 1									T
2	4.27	4.91	6.70	8.17	9.22	6.98	6.69	8.18	.04
3	13.10	13.38	13.16	13.71	13.60	13.83	13.58	14.02	.21
4	12.08	12.22	12.43	12.77	13.21	12.90	12.63	12.68	
5	8.43	8.72	10.38	9.81	10.64	9.39	9.00	9.81	
6	6.53	6.67	8.68	8.90	10.05	7.01	7.38	8.62	
7									.02
8									T
9									.02
10	4.79	5.52	7.75	7.67	9.80	6.62	7.12	7.70	
12	3.28	3.83	5.95	5.86	7.64	5.00	5.09	6.13	
15									.02
16	3.60	4.48	6.47	6.92	8.27	5.40	6.03	6.48	
17									.11
19	6.23	6.39	7.68	8.36	9.10	7.87	7.72	8.23	
20	3.75	4.36	5.57	6.19	7.22	5.41	5.34	6.45	
22									T
23									.01
24									.07
25									.21

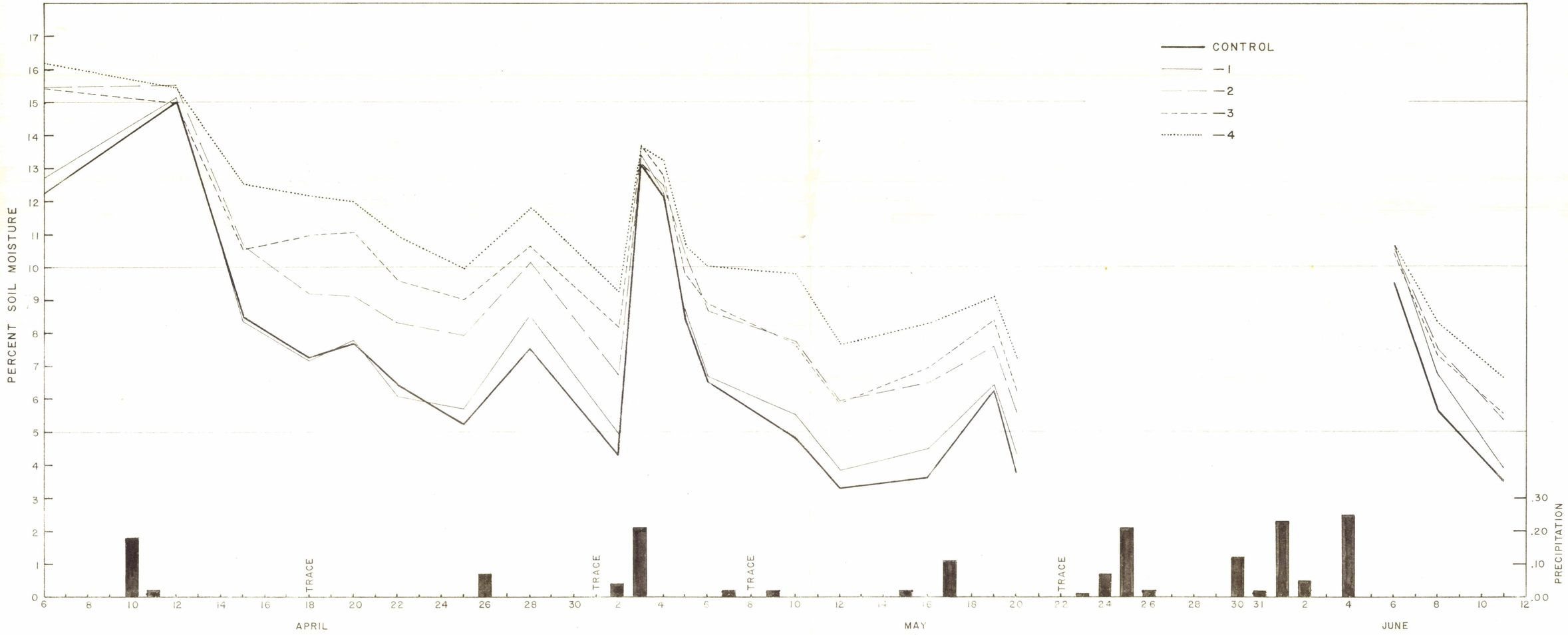
Continued on Following Page

Continuation of previous page

Date	Average soil moisture								Precip-itation
	Control	-1	-2	-3	-4	+3	½+2,-2	+2,-2	
May 26									.02
30									.12
31									.02
June 1									.23
2									.05
4									.25
6	9.55	10.67	10.64	10.43	10.66	9.96	10.39	10.41	
8	5.64	6.81	7.53	7.33	8.33	6.89	7.64	7.67	
11	3.51	3.93	5.39	5.62	6.67	4.31	4.69	5.76	
Average	7.36	7.77	9.26	9.70	10.73	8.64	9.08	9.69	

L.S.D. .05 = .78
L.S.D. .01 = 1.09

DEEP FURROW STUDY — 1955



"+2,-2" is compared to the 3 inch furrow "(-3)" it can be seen that they were almost identical in soil moisture on most dates. Why the "+2,-2" should be so similar to the "-3" (when the "+3" is not) has not yet been determined. The "+2,-2" gives an appearance in cross section that is not greatly different from a listered field. This could indicate that the use of a lister for range reseeding might not be such a bad idea.

The single 2 inch ridge beside a 2 inch furrow "($\frac{1}{2}$+2,-2)" gave no improvement over the 2 inch furrow alone "(-2)". Actually, because of soil sloughing off the ridge into the furrow, the added ridge was probably detrimental.

A separate set of plots was set up containing a control, "-1", "-2", "-3", and "-4" treatments. These plots were seeded with Nordan crested wheatgrass. Nothing but trouble came from this planting. What was thought to be an identical method of covering the seed, although slightly different in mechanics, in the control plots turned out to be much different from the method used in covering the seed in the furrows. This resulted in seedling counts in the control plots being better than in most of the furrows; this situation is not logical. Furthermore, when final seedling counts were being made, it was found that grasshoppers were there first and that they had done a thorough job of eliminating the seedlings. For whatever interest it might be, the seedling counts made on May 17 (before the grasshopper invasion) are shown on the following page.

Treatment	No. seedlings per foot of row
control	.83
-1	.00
-2	.67
-3	3.08
-4	8.67

Discussion:

From the standpoint of improved soil moisture conditions, the use of deep furrows appears to be adviseable where dry surface soil in the spring is a problem. However, before the use of deep furrows can be generally recommended, there are three things that need further consideration; these are: (1) the influence of the furrow on the microclimate surrounding the seedling, (2) the effect of soil sloughing into the furrows, and (3) the lack of suitable equipment for deep furrow planting.

Although the use of deep furrows does provide better soil moisture conditions for the germinating seed, the effects of a furrow on soil temperature changes and ground layer air temperatures have not yet been determined. The possibility of ice accumulation in the furrows at high elevations and the collection of snow and rain runoff must also be considered. It may well be that the effects of the furrows on micro-climate may all be beneficial, but this must be definitely determined. Some preliminary investigations along this line are planned for the next field season.

One of the principal objections to the use of deep furrows has been the sloughing of soil from the walls and top of the furrow into the furrow bottom. D. W. Pittman mentioned to me that on the Nephi Dry Farm following heavy rainstorms, the furrows are filled level full with eroded soil. The combination of sloughing and erosion are frequently enough to kill the seedling stand. Further study must be made to determine the most stable type of furrow for use in various soil types. The slope of the side walls of the furrow is probably the factor to work with. However, changing the sidewall slope will undoubtedly change the effectiveness of the furrow in reducing evaporation. The interrelationships of sidewall slope, soil sloughing and soil moisture loss must be determined. A study of these inter-relations is planned for next season.

The standard deep furrow grain drill has not generally proved satisfactory for range reseeding. It is subject to breakage and will not cut a deep enough furrow in compact soils. It will be necessary to develop a more satisfactory machine for making and planting deep furrows, but this could well wait until more information on the most desireable depth and cross-section shape of the furrows is available. Some consideration might be given to furrowing a field to an appearance similar to "+2,-2" and then broadcasting the seed over the area; it would be necessary to depend on sloughing soil to cover the seed. Although this method would probably require seed being applied at a

heavy rate, it might be cheaper and more satisfactory than trying to develop a drill for the purpose. No work on this phase is planned for this year.

SEED TREATMENT STUDY

In some of his recent studies (unpublished), N. C. Foushknecht found that when seed is planted in the fall, a considerable amount of seed is lost to fungi during the winter. Losses are much lighter on spring planted seed. However, spring planting is usually impractical because the rapid drying of the soil seriously limits the time during which planting can be done successfully. It also appears that the vernalization resulting from over-wintering in the soil may have some beneficial effects.

To try to find a method of reducing this loss of seed during the winter, a study was established at three elevations in the fall of 1954 (See Appendix, 1954 Annual Report, Ephraim, Utah). Briefly, this study involved planting 100 seeds treated with arasan and 100 untreated seeds of each species with five replications. Six or seven adapted species were planted at each elevation.

In the spring of 1955, seedling counts were made on the Sorenson's Field and Major's Flat areas after emergence was well along (April 8 and May 18, respectively) at which time each seedling was marked by putting a toothpick in the ground beside it. Seedling counts were made again at the end of the growing season (June 28 for Sorenson's Field and August 9 for Major's Flat). It is being assumed that most of the seedlings still living at the time of the final counts are firmly established and will survive. It was the original plan to use

a combination of the early and late counts to get some indication of total germination. The toothpicks would make it possible to distinguish between early and late germination and would mark the former location of seedlings that had disappeared by the time of the final counts. However, it was found that a number of toothpicks became lost between the two counts making it necessary to use the final count only.

At Sorenson's Field, the loss of toothpicks was relatively small. Under the column heading "Total Germination" in the Sorenson's Field table, is shown what appears to be reasonably close to the actual total germination. It must be kept in mind that the actual total germination is somewhat higher than is shown.

The planting at Summit Enclosure was a general failure. Germination was very poor for all species. No reason for the poor germination could be found. Most of the seedlings that did emerge were destroyed by grasshoppers. Because of the extremely poor germination and heavy seedling loss, no conclusions can be drawn from the Summit Enclosure data.

Even a casual examination will show that there are significant differences between species insofar as germination and survival are concerned at Sorenson's Field and Major's Flat. These differences proved to be highly significant when subjected to analysis of variance. However, the differences between treated and untreated were not significant. Thus, no benefit was derived from applying Arasan to the seed.

It is possible that some other fungicide might have been more effective than Arasan. However, it is doubtful that another fungicide could produce enough difference to be worthwhile. It appears that other seedling losses are so great that future work should be directed toward saving those seedlings that do emerge. In the Sorenson's Field table, it will be noted that total germination is substantially greater than survival at the end of the season. It should also be remembered that the total germination figures are lower than the actual total germination. Saving those seedlings that die during the first year could easily mean the difference between success and failure in range reseeding. Although it would be desireable to eliminate seed losses to fungi during the winter, saving the seedlings that do emerge is probably more important and should be given first consideration. When this has been accomplished, further studies with seed treatment should be undertaken.

ARASAN STUDY

SORENSON'S FIELD

Species	Average Germination Treated Seed* 6/28/55	Average Germination Untreated Seed* 6/28/55	Total Germination for season	
			treated seed	untreated seed
Agropyron cristatum (Standard)	24.20	17.60	54.40	48.00
Agropyron cristatum (Fairway)	6.80	9.00	26.00	28.40
Agropyron inerme	16.20	14.40	35.20	32.60
Agropyron smithii	0.00	0.00	0.00	0.00
Elymus condensatus	1.80	2.40	3.80	4.40
Elymus junceus	12.20	10.00	30.20	24.80

*living seedlings only

ARASAN STUDY

MAJOR'S FLAT

Species	Average Germination* Treated Seed 8/9/55	Average Germination* Untreated Seed 8/9/55
Agropyron cristatum (Standard)	9.67	10.67
" elongatum	21.00	23.00
" inerme	12.17	13.17
" intermedium	22.50	22.33
Bromus inermis	10.00	12.00
Elymus condensatus	7.83	12.17
" junceus	5.33	4.67

*Living seedlings only

ARASAN STUDY

SUMMIT ENCLOSURE

Species	Average Germination* Treated Seed 8/30/55	Average Germination* Untreated Seed 8/30/55
Agropyron trachycaulum	14.60	13.40
Alopecurus pratensis	1.40	2.00
Arrhenatherum elatius	2.60	.80
Bromus inermis	3.60	3.80
Dactylis glomerata	1.00	.60
Phleum pratense	1.60	2.60

*Living seedlings only

PRELIMINARY FERTILIZER INVESTIGATIONS

During the spring and summer of 1954, preliminary fertilizer trials were established on an old growth stand of crested wheatgrass and a seedling stand at Sorenson's Field. Similar trials were established cooperatively with Gordon A. Van Epps on an old seeded stand at Major's Flat, on native vegetation in the sub-alpine zone, and on an old stand of smooth brome in the sub-alpine zone. These trials were put out only to see if any reaction to fertilizer could be observed. It was not the intent that the best rates or time of application would be determined. It was hoped that these studies would provide some clues upon which to base future studies.

All of these trials are of similar design. The individual plots are one rod square; two blocks are used. Fertilizer was applied to one plot in each block at the following rates:

Available nitrogen	50 lb/A
Available phosphoric acid	84 lb/A
Available nitrogen at 50 lb/A + Available phosphoric acid at 84 lb/A for a total of	134 lb/A

One plot in each block was retained as a control. The fertilizer was broadcast by hand and an effort made to distribute it as uniformly as possible.

Positive results were observed on only two of these sites. On the old stand of crested wheatgrass at Sorenson's Field (where the fertilizer was applied on March 16) a substantial color difference

was observed shortly after the fertilizer was applied, and due entirely to the nitrogen. No response to phosphorus was observed. No particular differences in yield were observed between fertilizers and the control. It was noted that nitrogen seemed to encourage better color and growth, but the nitrogen plots dried up earlier with the result that the total yield was no better than where nitrogen was not applied.

Positive results were also observed from the fertilizer applications made on the old stand of smooth brome in the sub-alpine zone. This stand of smooth brome was planted in about 1914 and had become quite rod-bound. The fertilizer was put on July 20, 1954. A slight color difference due to nitrogen was observed during 1954. It was also noted that the nitrogen plots were still green on October 1, while on the plots where nitrogen was not applied, the grass turned brown in mid-September; this phenomenon was not observed in 1955. Herbage samples were clipped on September 10, 1955 and air dry yields per acre computed to be as follows:

nitrogen added	1702 lbs/A
nitrogen + phosphorous added	1595 lbs/A
phosphorus added	638 lbs/A
control	674 lbs/A

Analysis of variance indicates that differences are significant at the 5 percent level. The least significant difference for 5 percent significance is 437 lb/A. It will be interesting to see if

this difference persists in 1956.

Two fertilizer trials were put out in 1955. One of these was put out on the Bear Creek plots (Study B-156). This study is a species adaptability study in the sub-alpine zone. It is located on a south-facing sidehill from which most of the top soil has eroded leaving a pavement of limestone and shale. It is classed as a very severe site. The study was planted in 1948. Smooth brome, tall oatgrass, slender wheatgrass, and quackgrass became established, but yields have been very low. No species produces a ground cover adequate to control erosion. On August 17, 1955 fertilizer was broadcast on block II of this study at the rate of 66 pounds available nitrogen per acre plus 42 pounds available phosphoric acid per acre. Frequent rains occurred during the two weeks following the application. Within three weeks, a marked color difference was evident. On October 21, after examination of the area, it was estimated that the fertilized area was producing 50 to 100 percent more herbage than the unfertilized area (no plots were clipped), and it was noted that the grasses on the fertilized area were still green, while on the unfertilized area, they had turned brown.

This trial was put out for the sole purpose of observing the effects of fertilizer on harsh sub-alpine sites. The favorable response observed here served as the basis for the two sub-alpine tough site studies put out in October. It is concluded that the application of fertilizer to established grasses on harsh sites in

Smooth brome planted in about 1914. Plot on the left treated with 50 pounds available nitrogen on July 20, 1954. Plot on the right received no nitrogen. Application of nitrogen about trebled production in 1955. Picture taken 9/9/55.

the sub-alpine zone will result in a pronounced increase in forage yields. The effects of fertilizer on seedling establishment is yet to be determined.

A study was put out this year in the head of Pleasant Creek in the sub-alpine zone in cooperation with G. A. Van Epps. The Forest Service is plowing, terracing, and reseeding a sizeable acreage in this area in connection with a Small Watershed project. This trial was put out on August 8, 1955 on an area adjacent to the Skyline Drive in the head of Blue Slide Fork. The study area had been plowed, terraced, and seeded about a week before. The following treatments were applied:

1. control
2. 50 lb available N
3. 100 lb available N
4. 84 lb available phosphoric acid
5. 50 lb available N plus 84 lb available phosphoric acid

The primary purpose of this study is to observe the effects of fertilizer application on seedling establishment. Any results will probably serve as groundwork for a more formal study.

Bear Creek plots (Study B-156). The plots on the left-hand side of the picture were fertilized with nitrogen and phosphorus on August 17, 1955. The plots on the right were not fertilized. The fertilizer increased yield and improved the color of the grasses. Picture taken 10/6/55.

BAND SEEDING TRIALS

Because of the success obtained with band seeding in other localities, observational studies were established in the fall of 1954 in the sub-alpine, mountain brush, and greasewood types. No band seeding equipment was available, so the planting was done with a make-shift arrangement. The fertilizer was put in with a Planet Jr. with the planting shoe set as deep as it would go. A mixture of equal volumes of ammonium nitrate and treble-super phosphate was thus drilled in at a depth of 1½ to 2½ inches. A mixture of species adapted to the particular site was then drilled in at ½ inch depth immediately over the fertilizer bands again using the Planet Jr. The seedbeds had previously been prepared by cultivating with a Merry Tiller.

All three of these seedings were general failures. It would be impossible to determine whether or not the band placement of fertilizer was of any benefit because of the extreme scarcity of seedlings under either treatment. The reason of these failures is not entirely evident. However, judging from the soil movement during the winter, I would guess that the seedbed was looser than it should have been. It also appeared that the Planet Jr. did not do a satisfactory job on this type of planting. For one thing, the Planet Jr. does not adequately firm the soil covering the seed. It also leaves a mound of soil over the seed; the best results in seeding these dry sites usually come from planting in the bottoms of furrows.

The study of band seeding has been temporarily discontinued. When satisfactory equipment for experimental band seedings is found, the studies will be continued. There seems to be little sense in continuing a study when lack of satisfactory equipment predestines the study to failure. However, band seeding should be given a good trial as soon as possible, and the search for suitable equipment is continuing.

TOUGH SITE STUDIES

Over the years, most research in range reseeding has been directed toward the better sites of higher potential returns. The general attitude has been that the cost of reseeding must be returned in increased forage production. Within the last few years, a great deal of interest has been shown by the land administration agencies toward reseeding some of the less favorable sites. The question of cost in relation to forage production no longer seems to be such a serious barrier. Much of the change in thinking is the result of using range reseeding on a large scale for watershed management and flood control. Because of the large number of watersheds now being treated under the Small Watershed Act, the need for knowledge of how to reseed the more severe sites, which are frequently flood source areas, is becoming critical. There seems to be little point in rehabilitating a watershed unless all of the flood source can be effectively treated. At present, we can get successful reseeded stands on the better sites, but these are frequently not the flood source areas.

In order to try to get some information as to what might be required for getting good stands of reseeded grasses on these tough sites, studies were put out on two sites in the sub-alpine zone. The studies are identical in design, but differ in the type of site they are on.

The "Alpine" site is located on the ridgetop between Experimental

Watersheds A and B, and just west of the Skyline Drive. Elevation at this site is 10,200 feet. This ridgetop has for many years been used as a sheep driveway and the most of the topsoil is gone. The area is very rocky, the rocks being fragments of shale and limestone. The native vegetation on the area before planting was a sparse cover of Stipa lettermanni, perennial weeds and a few plants of Ribes sp.

The "Philadelphia Flat" site is located on a terrace just below the ridgetop at an elevation of approximately 9,950 feet. The native vegetation of this area, although once luxuriant, has been severely depleted. Just after World War II, the area was plowed and reseeding was attempted; the reseeding was a failure. The area was replowed and another failure followed. At the time of planting of this study, the remaining vegetation consisted of a poor stand of lupine, viola, and annual weeds. The soil on this site is not bad to look at, but the number of failures would indicate that something is lacking.

Precipitation at both sites is estimated to be about 35 inches annually with about 80 percent of this coming as snow.

The plowing of both areas was accomplished with a Merry Tiller. On Philadelphia Flat, a good job of plowing to a depth of about 4 inches was obtained; however, this will not be enough to kill all of the lupine and some plants will sprout back next year. In the case of the Alpine area, the cultivation did little more than stir the rocks around, and kill some of the grass. Following the cultivation, the areas were divided into two blocks and half of each

block was furrowed with furrows 4-6 inches deep and spaced 2½ feet apart. The area was then divided into plots 10 by 20 feet in size. Later, these plots were divided into two sub-plots with one sub-plot being mulched with straw; the mulching was done after the seed and fertilizer had been put on.

One furrowed and one unfurrowed plot in each block were fertilized at the following rates (pounds per acre refers to pounds of available nitrogen):

	lbs per acre
Ammonium nitrate	25
" "	50
" "	100
" "	200
" "	400
"Morgro", 6-10-4	50
Control	0

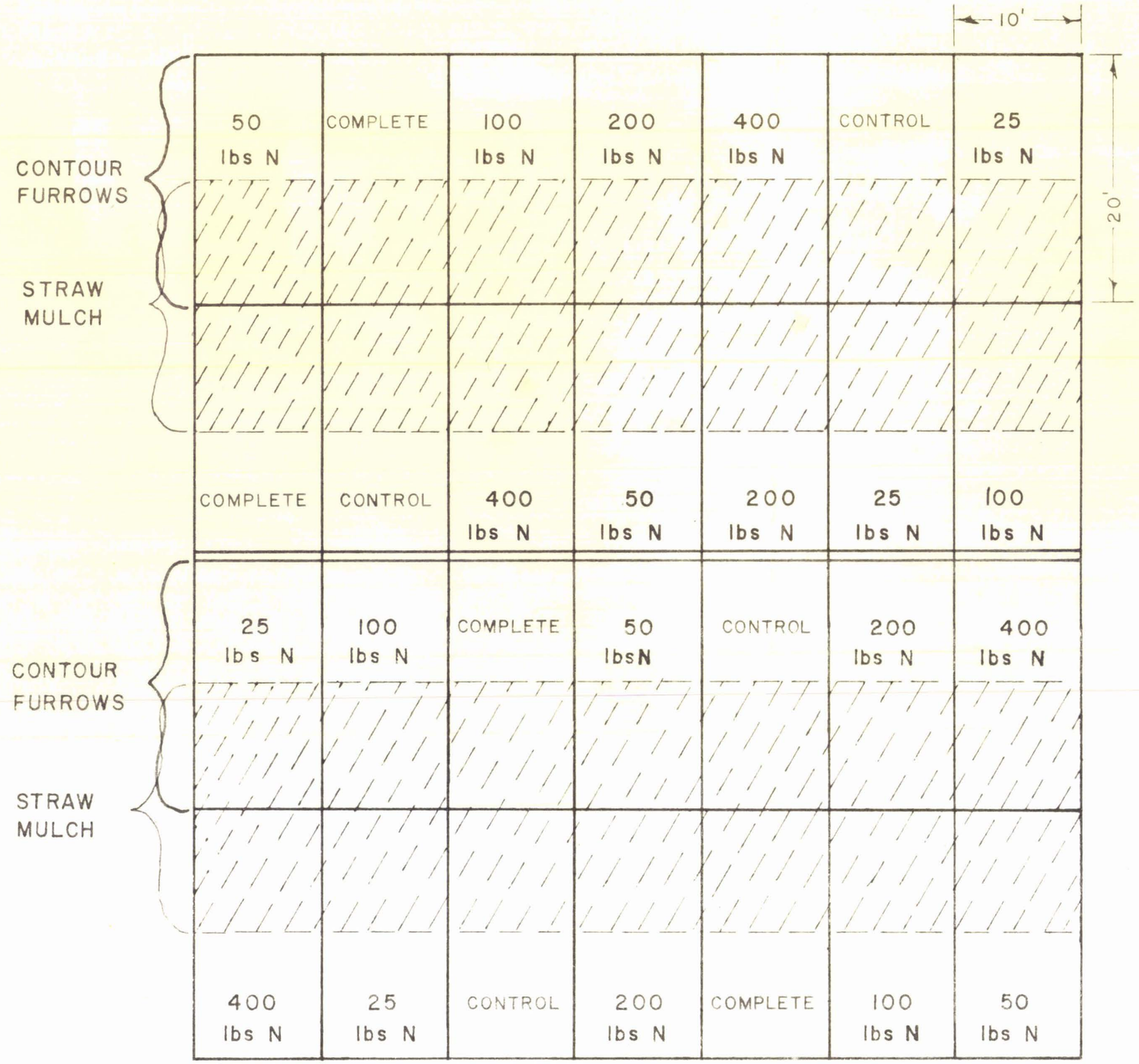
The plots were then hand broadcast to the following mixture at the rate of 30 pounds of mixture per acre:

Species	Lot No.	Parts in mixture
Smooth brome, Manchar	80	2
" " , Lincoln	81	2
Tall oatgrass	33	1
Orchardgrass	40	2
Mountain brome	---	1
Slender wheatgrass, Primar	116	1
Alfalfa	F.C.23905	1
	Total	10

After the plots were fertilized and seeded, the sub-plots were mulched with oat straw at the rate of one bale to 350 square feet. This produced a mulch 1-2 inches deep.

Because of high winds and blizzards at the time these studies were put out, there was a certain amount of drift of fertilizer and

seed on to adjacent plots. The distribution of the seed will probably show up as being a bit uneven, but this could not be prevented under the circumstances. The wind also blew some of the straw off of the mulched plots, but not enough was blown off to leave the ground bare. After several light snows had fallen, movement of the straw by wind was greatly reduced even though the snow melted off and left the plots fairly dry.



N ← ALPINE AREA
OCT. 4, 1955

N ← PHILADELPHIA FLAT
OCT. 4, 1955

General view of the native vegetation adjacent to the Philadelphia Flat tough site study area. The actual plot area was similar in appearance prior to plowing. Picture taken 10/6/54.

Philadelphia Flat tough site study, furrowed plots, unmulched on right, straw mulch on left. Picture taken 10/6/55.

General view of Alpine tough site study area. The undisturbed native vegetation in the foreground is similar in appearance to the vegetation on plots prior to cultivation. Picture taken 10/6/55.

Alpine tough site study, unfurrowed plots. Straw mulch on the left, unmulched on the right. Picture taken 10/6/55.

MISCELLANY

On the following pages are several writeups and comments on work that has been done here, and these are put in this section for lack of a better place.

Dryland Alfalfa:

There has long been a desire to find a legume suitable for range reseeding. Some of the dryland alfalfas appear to be as promising as anything that has been tried here. The only two other species that have shown up well here are Astragalus falcatus and A. cicer, but so little is known about these two that range plantings with them are still in the pilot stage.

Of all the alfalfas tried, the two that have looked consistantly good on dry sites are Ladak and a Medicago glutinosa hybrid. The exact origin of the hybrid has not been known, but it was recently possible to determine that this was originally sent out for test as A-169. This strain was sent out for testing in about 1941; it does not seem to have created much interest at other locations. I suspect the lack of interest was due to its being tested as a hay type on irrigated land. However, some of this seed was planted at Sorenson's Field in 1941; it became well established and has been the only strain of alfalfa to maintain a full stand for so long a time in this low rainfall area. It is also known to resist grazing well at 15-20 inches of rainfall. It is a strain that looks very promising and is certainly worthy of further testing.

When an attempt was made to obtain more seed, it was found that none was available. No facilities are available for raising pure seed at Ephraim. After talking it over, Marion Pedersen agreed to try to raise some seed in cages at Logan, Utah. On April 14, a number of plants that were grown from the original 1941 seed were dug up and taken to Logan. In a recent conversation, Mr. Pedersen told me that the plants had been set out with a very small loss. Some seed was collected this year. He hoped to get this planted for further increase so that enough seed would be available for a more extensive testing of this strain at other locations in the West.

Range Reseeding Equipment:

Contour terraces are usually constructed primarily as a flood and erosion control measure. However, they have an important place in range reseeding when it is necessary to work on steep slopes. One of the frequent problems encountered in reseeding on mountain ranges is stabilizing the site during the period when the grasses are becoming established. Although terraces alone are not satisfactory, when used as a supplement to contour furrows and a rough seed bed, most major erosion problems can be eliminated, long enough to allow the reseeded grasses to become established.

Because of the interest indicated at the 1955 Range Reseeding Committee meetings in the use of the "hula-dozer" for constructing contour terraces, some observations on this machine were made during the summer. The hula-dozer is a hydraulically controlled bull dozer

blade developed by Henry Mullin of Region 3 of the Forest Service. By means of the hydraulic cylinders mounted on the dozer frame, the blade can be tilted and oscillated at will by using two control levers mounted beside the driver. The dozer cannot be angled. The blade is also equipped with four "cat claws" or ripping teeth; only the two outside teeth were in place on the dozer observed. The hydraulic cylinders and cat claws can be clearly seen in the following photograph. This hula-dozer was being used to construct contour terraces on the Pleasant Creek Small Watershed Project; it is owned and operated by the Forest Service.

The following comments about the hula-dozer are based on reports by the operator and my own observations.

1. The hula-dozer, although still in the developmental stage, appears to be very sturdy and relatively free from trouble. It is easy to operate. The blade observed was mounted on a D-7 Caterpiller, but it is the same size blade that would be used on a D-8. It appeared to be too heavy for the D-7 and created an unbalanced outfit. The operator also reported the blade was so high that he had trouble telling when he was getting the proper load in it. The blade was sturdy enough that the heavy rocks did not damage it.

2. The hula-dozer could be used in places far too rocky for the standard bull-dozer. However, at least part of the additional effectiveness of the hula-dozer in rocky situations was a result of the ability of the cat claws to get under and dislodge rocks. The

Hule-dozer equipped with cat claws constructing contour terraces on the Pleasant Creek Small Watershed Project.

combination of hula-dozer and cat claws makes a combination that is unbeatable in rocky conditions; if either the hula-dozer or cat claws were used alone, the total effectiveness would be greatly reduced. On rock-free sites, the cat claws could probably be dispensed with.

3. The usefulness of the hula-dozer is greatest when making the first cut on a contour terrace. After the first cut has been made, a standard bull-dozer can finish up the terrace and put in the check dams.

4. The hula-dozer was used on slopes up to about 65 percent. Although it was not tried on slopes greater than 65 percent, it is doubtful that it could be used successfully on steeper slopes. Actually, efficiency falls off when the slope exceeds 40 percent.

5. This is not a one-purpose machine. Mr. Geroge Allred, road forman for the Manti-LaSal National Forest, reports that the hula-dozer is very good for general construction work and road maintenance.

CHEMICAL PLANT CONTROL

During the spring of 1954, tests were made on two new chemicals furnished by the Dow Chemical Company. These tests were very preliminary in character. They were not made with the idea of providing conclusive results, but rather, with the idea that if these chemicals showed promise, it might be possible to get other workers to go ahead with them. There is an urgent need for work in noxious plant control on the intermountain ranges, but very little is being done about it. Both chemicals tried show promise and should be given further trials.

Kuron:

The first chemical tried was Kuron, also known as Silvex. This is similar to 2, 4, 5-T in formulation and action. It was initially planned to try this on Gamble's Oak, but a late frost killed most of the leaves on the oak and no fair trials could be made. It was tried on young growth rabbitbrush (Chrysothamnus nauseosus) and Utah juniper. Both Kuron and Dow Brush Killer (used as the control) were applied with a hand sprayer at rates of 1,000, 2,000, and 4,000 p.p.m. in water solution. Ten plants of each species were treated with each chemical at each rate, making a total of 60 plants of each species treated. The work was done on the Rasmuson farm south-east of Ephraim. Spraying was done on May 13, 1954. At this time, both species were fully leafed out and the leaves were about 3/4 of full size.

Other than a very slight yellowing of the tips of the leaves, no effects of the chemicals were observed on the Utah juniper. It is known that the leaves can be "burned off" of juniper with 2, 4, 5-T, but it apparently requires much higher rates of application than were used here.

No attempt was made to rate the effects of the two chemicals on rabbitbrush until June, 1955. At this time, the kills were as follows:

		Percent of Plants Killed
Brush-Killer	1000 ppm	0
" "	2000 ppm	86
" "	4000 ppm	100
Kuron	1000 ppm	29
"	2000 ppm	56
"	4000 ppm	100

It should be noted that all of the rabbitbrush plants treated had been grazed by sheep in previous years and no stems over two years old were present at the time of spraying. The sprayer was emptied out by spraying on some old plants nearby. None of these plants were killed, although some were temporarily defoliated.

Although it has generally been felt that rabbitbrush cannot be controlled with selective herbicides, this informal study would indicate that at least young brush can be killed. Because of the mounting problem of controlling rabbitbrush invasions on reseeded range, these two herbicides should be given further trials.

Dalapon:

There are extensive acreages of salt grass in the valleys of Utah. Saltgrass produces very little forage, but most of these areas are capable of producing good yields of reseeded grasses. The biggest problem is to eliminate the saltgrass. Plowing must be very deep and must be done for several consecutive years to get a good kill. The amount of power required for plowing the heavy saltgrass sod in heavy soils is tremendous. The difficulty of cultivating the saltgrass areas has been primarily responsible for the small amount of reseeding done in this type. Thus, anything that could be done to reduce the severity of this problem would be a great help.

It is with this thought in mind that a preliminary study to test the effectiveness of Dalapon on saltgrass was initiated in 1954. Dalapon was applied at the rates of 10, 20, 30, 40, and 50 pounds of the sodium salt per acre on rod square plots on the John K. Olsen farm north of Ephraim. Application was made with a hand sprayer at a rate of 80 gallons of solution per acre. Spraying was done on June 16, 1954. At this time, the saltgrass was making good vegetation growth, but no seed heads had been formed.

Observations were made on June 3, 1955 to determine the degree of kill. Percentage kills (average of two plots) were estimated to be as follows:

lb per acre of sodium salt of Dalapon	Percentage kill
10	78
20	55
30	85
40	75
50	78

The amount of kill appeared to be more nearly related to the degree of coverage by the solution than by the rate of application. It was noted during 1954 that those leaves that were covered by other leaves or litter at the time of spraying were not affected, but almost all of the leaves that were touched by the spray were killed. It appears that some much more effective method of spraying or treatment prior to spraying must be developed in order that all leaves will be covered with solution.

In general, I feel that Dalapon holds great promise in the elimination of saltgrass. Mr. Gordon Van Epps of the Utah Agricultural Experiment Station (Mr. Van Epps is stationed at Ephraim, Utah) has become interested in Dalapon and is presently planning to carry on additional trials with it. It is hoped that he will be able to develop a successful method of economically eliminating saltgrass using Dalapon or something similar.